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ABSTRACT

The purpose of this study was to select a high school using the Individualized Instructional System (ISIS) materials and the Introductory Physical Science (IPS) course and to detect any changes in the students' attitudes toward science and ability to employ specific processes of science at the end of a semester of coursework. Wayne, Nebraska, High School was selected since both ISIS and IPS are taught in it at grade level nine. Twelve students in one section of ISIS and 71 students in four sections of IPS were involved in the study. Two instruments, the Test of Science Processes (TSP) and the Science Attitude Inventory (SAI), were administered as pretests and posttests to collect data. No significant difference between groups was observed on the TSP. Negative gains on means scores on the SAI were observed. Analysis of the attitudes examined by the SAI showed that the IPS students showed significant gains over the ISIS students. (GA)

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A Comparison of Attitudes and Knowledge of Science Processes of a Select Group of Ninth-Grade ISIS and IPS Students

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The emphasis in science education during the 1960's could be characterized as revolutionary. The educational system of the United States came under heavy criticism. Russia, at that time, was considered scientifically and technologically inferior to the United States. However, an artificial satellite had upstaged the space program of the United States. Suddenly there was considerable concern for the teaching of science. "Life Adjustment" education was viewed as inadequate. Considerable emphasis was placed upon the "structure of a subject" and "scrupulous intellectual honesty" (Bruner, 1960). The generalization was that any discipline could be taught in an intellectually honest form to any student in any stage of intellectual development. The learner learned science best functioning as a scientist. Concentration was directed toward teaching to the limit of children's competence (Bruner, 1971).

A host of courses were developed in the late 1950's and early 1960's, sponsored initially by the National Science Foundation and several private foundations and later on by the U.S. Office of Education. The program purpose of the National Science Foundation was to produce improved current course materials by employing leading scientists to develop course content through research.

Although inquiry methods were advocated, the thrust of the national curriculum projects was academic excellence. Textbooks were developed around large themes or principles of science to provide unity and sequential continuity. Concepts appearing early in courses were used later for

SE 025 018

explanation or expansion of related concepts and theories. Understandings were preferred over memorizations. Retention, meaning and intellectual usefulness were to be increased by the in-depth teaching of concepts (Hurd, 1964). Watson (1968) makes the point that the curricular projects were funded only when scientists were the directors of such programs. Such leadership invariably led to course revisions with academic orientations. Andrews (1970) takes the position that the national curricular projects were geared to the potential science major, with scientific literacy occurring through serendipity. Smith (1966) and Gatewood (1968) labeled the "new curricula" as "elitist". Kline (1965) argues that the professional scientists assumed mathematics and science to be ends in themselves and the curricula they produced were designed to train professionals.

The social atmosphere of the United States during the latter part of the 1960's was different than that of the latter 1950's. Cultural, social, political and environmental problems were foremost. Students were rioting, ethnic groups were clashing and we were involved in the Viet Nam War. The goal of placing a U.S. citizen on the moon had been achieved with accompanying de-emphasis on the space programs. Scientists and engineers were in oversupply. Former values were being openly challenged.

A career in science no longer was popular and respected by young people as it once was. In fact groups of youth openly attacked science as the perpitrator of environmental problems and some held it suspect as a program for creating war machines.

Educators became concerned with declining enrollments in science during the 1970's. In October of 1971, a group of educators met in Calloway Gardens, Georgia to consider the present status of high school science education and to identify strategies for improvement. It was

established that the science education programs of the 1960's are seriously limited for the youth of the 1970's (Burkman, 1972). It was agreed that the gap between high school science programs and the needs and interests of students will widen in the future unless program alterations are soon made.

The Calloway Gardens Conference cited authoritarian teaching methods, irrelevant content and centralized decision making as factors in inhibiting science programs in meeting the needs of society and students. Apparently the teaching of science is failing in communication with students since negative attitudes toward science are becoming more prevalent. The consensus which emerged from the conference is that the present science programs are out of phase with the students because: (1) the teaching of science is teacher directed and group centered with little concern for individual learning rates, interests, abilities or learning styles, (2) pure science is over-emphasized at the expense of applied science, (3) there is little provision for interdisciplinary sequencing, (4) instructional science materials are inflexible, (5) instructional goals are poorly defined, and (6) little provision is made for general education in science.

Foshay (1970) states that the discipline oriented science curricula developed in the 1960's have the limitations of: (1) not providing for integration of knowledge, (2) not being directly relevant to life, (3) failing to take into account the need for and the nature of teacher education, and (4) were designed primarily for college bound students. He accused the projects of exclusively committing the students to continued work in specific disciplines.

One answer to the growing concern about science curricula has been the development of individualized instructional materials. However, the basis

for supporting individual instructional materials appears to be philosophical rather than reserach based. A survey of the literature by this researcher indicated relatively little conclusive evidence either pro or con in respect to individualized instruction.

The purpose of this study was to select a high school using the Individualized Instructional System (ISIS) materials and the Introductory Physical Science (IPS) course in a classroom and to detect any changes in the students' attitudes toward science and ability to employ specific processes of science at the end of a semester of coursework.

The ISIS curriculum materials and the IPS course have marked differences. The IPS course was designed to help students develop a certain level of sophistication in functioning as scientists, whereas the ISIS curriculum materials are designed to teach science concomitantly as the student studies everyday problems. ISIS is a set of curriculum materials which can be arranged by the teacher and/or students into a curriculum package suited to specific individual needs. The student is encouraged to progress at his own rate and to make decisions as to sequence. The IPS materials represent a curriculum built upon a central theme which follows a specific sequence. IPS tends to deal with theoretical science while ISIS deals with applied science. A considerable amount of rather technical reading is involved with IPS. Reading is kept to a minimum with ISIS and the reading required is in terms of current jargon and at a fairly low level.

PROCEDURE

Wayne, Nebraska, population 4,800, was selected for this study since

both ISIS and IPS are taught in the high school at grade level nine. Wayne is predominatly an agricultural community with five manufacturing plants employing 85 people. Wayne State College with an enrollment of 2,232 is located in Wayne (Nebraska DED, 1976).

Twelve students in one section of ISIS and 71 students in four sections of IPS under one instructor were involved in the study. The IPS sections used the IPS textbook, Introductory Physical Science published by Prentice Hall, Inc., Englewood Cliffs, New Jersey. The ISIS section used the following fifteen minicourses published by Ginn and Company, Cambridge, Massachusetts:

HEART ATTACK
KNOW THE BUG
FOOD AND MICROORGANISMS
GETTING ENOUGH OXYGEN
GUT REACTIONS
GENERATION LINK
PACKAGING PASSENGERS
SOUNDS OF MUSIC
USING THE SKIES
STORMY WEATHER
PLANTS INDOORS
WAYS WE LEARN
HOUSEHOLD ENERGY
BUYING AND SELLING
SNAKES AND OTHER CRITTERS

Adequate equipment was available to operate both programs, with complete commercial kits provided for each ISIS minicourse.

The Test of Science Processes (TSP)(Tannenbaum, 1968) and the Science Attitude Inventory (SAI) (Moore, 1970) were administered during the week of September 6, 1977. The same inventories were again administered at the end of the semester during the week of January 18, 1978.

The TSP is an instrument designed to diagnose weaknesses and assess achievement in using science processess by students at the grades 7-9 level. Eight science processes considered are: Comparing, Observing, Quantifying, Classifying, Experimenting, Measuring, Inferring, and Predicting. The instrument contains 96 five-item multiple choice items with a total allowed testing time of 73 minutes. Each item in the test booklet has a black and white illustration with the first twelve items supplemented with 35-mm color slides.

The SAI contains 60 statements to which the respondent has the choice of (1) agree strongly, (2) agree mildly, (3) disagree mildly or (4) disagree strongly. Twelve scales consisting of six positive attitudes and six opposing negative attitudes are derived from specific statements in the inventory. Each item of the inventory is categorized and weighted for scoring purposes.

ANALYSIS

Analysis of pre and post inventory data (Table 1) shows mean gain scores on the TSP of ten for the ISIS group and slightly over six for the IPS group. Further inspection of Table 1 indicates lower posttest scores than pretest scores by both groups on the SAI.

Table 1

Means and Standard Deviations of Process and Attitude Data

	TSP				SAI			
PROGRAM	Pretest		Posttest		Pretest		Posttest	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
ISIS (N=12)	39.4	13.8	49.8	12.9	186.3	16.8	152.4	55.3
IPS (N=71)	57.9	15.82	64.2	13.6	194.9	10.0	187.5	12.3

An analysis of the covariance was computed on the basis of Pretest TSP data and general educational achievement. The two variables chosen as covariates were: (1) pretest TSP scores and (2) total scores on the Iowa Test of Educational Development (ITED) (Table 2). No significant difference was observed between the ISIS and IPS posttest scores in respect to these covariates.

Table 2

ANCOVA
TEST OF SCIENCE PROCESSES

Source of Variation of F	SS	DF	MS	F
CoVariates: ITED (Science)	383.73	1	383.73	6.89
Pretest - Processes	5,836.13	1	5,836.13	104.83
Main Effects (IPS vs. ISIS)	83.34	1	83.34	1.50
Residual	4,398.06	79	55.67	

0.05 level
F = 3.97

A second analysis of the covariance was conducted with the TSP data. The variables chosen as covariates were: (1) pretest TSP scores and (2) the science section scores from a recently administered ITED test. Inspection of Table 3 shows no significant difference between the ISIS and the IPS posttest gain scores at the 0.05 level.

Table 3

ANCOVA
TEST OF SCIENCE PROCESSES

Source of Variation of F	SS	DF	MS	F
CoVariates: ITED (Total)	450.05	1	450.05	8.13
Pretest - Processes	3,949.07	1	3,949.07	71.36
Main Effects (IPS vs. ISIS)	43.22	1	43.22	0.781
Residual	4,371.86	79	55.34	

0.05 level
F = 3.97

Since the SAI posttest scores were lower than the pretest scores for both the ISIS group as well as IPS group, analysis of the covariance was computed on each of the twelve attitude scales of the SAI. The covariate variable was the pretest total scores for the SAI. Inspection of Tables 4 - 15 indicates no significance at the 0.05 level for scales 2-B, 4-B, 5-B and 6-A. Table 16 allows the reader to investigate the scales which had significant response. (See following pages).

Table 4

ANCOVA
SAI SCALE I-A

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	0.77	1	0.77	0.34
Main Effects (ISIS vs. IPS)	16.72	1	16.72	7.45
Residual	179.43	80	2.24	
				0.05 level F = 3.97

Table 5

ANCOVA
SAI SCALE I-B

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	1.80	1	1.80	0.36
Main Effects (ISIS vs. IPS)	20.06	1	20.06	4.04
Residual	397.13	80	4.96	
				0.05 level F = 3.97

Table 6

ANCOVA
SAI SCALE II-A

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	33.41	1	33.41	6.39
Main Effects (ISIS vs. IPS)	98.73	1	98.73	18.88
Residual	418.46	80	5.231	

0.05 level
F = 3.97

Table 7

ANCOVA
SAI SCALE II-B

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	3.25	1	3.25	0.74
Main Effects (ISIS vs. IPS)	16.49	1	16.49	3.75
Residual	351.67	80	4.40	

0.05 level
F = 3.97

Table 8

ANCOVA
SAI SCALE III-A

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	47.17	1	47.17	6.45
Main Effects (ISIS vs. IPS)	41.75	1	41.75	5.71
Residual	584.95	80	7.31	

0.05 level
F = 3.97

Table 9

ANCOVA
SAI SCALE III-B

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	118.57	1	118.57	14.42
Main Effects (ISIS vs. IPS)	39.27	1	39.27	4.78
Residual	657.96	80	8.224	

0.05 level
F = 3.95

Table 10

ANCOVA
SAI SCALE IV-A

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	35.44	1	35.44	5.52
Main Effects (ISIS vs. IPS)	67.92	1	67.92	10.57
Residual	513.86	80	6.42	

0.05 level
F = 3.95

Table 11

ANCOVA
SAI SCALE IV-B

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	10.44	1	10.44	1.42
Main Effects (ISIS vs. IPS)	9.17	1	9.17	1.25
Residual	589.01	80	7.36	

0.05 level
F = 3.97

Table 12

ANCOVA
SAI SCALE V-A

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	33.87	1	33.87	4.85
Main Effects (ISIS vs. IPS)	34.68	1	34.68	4.96
Residual	558.92	80	6.99	
				0.05 level F = 3.97

Table 13

ANCOVA
SAI SCALE V-B

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	36.00	1	36.00	5.75
Main Effects (ISIS vs. IPS)	10.53	1	10.53	1.68
Residual	501.32	80	6.27	
				0.05 level F = 3.97

Table 14

ANCOVA
SAI SCALE VI-A

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	0.41	1	0.41	0.11
Main Effects (ISIS vs. IPS)	2.36	1	2.36	0.63
Residual	299.45	80	3.74	
				0.05 level F = 3.97

Table 15

ANCOVA
SAI SCALE VI-B

Source of Variation of F	SS	DF	MS	F
CoVariates (Pretest Total)	34.45	1	34.45	3.52
Main Effects (ISIS vs. IPS)	71.85	1	71.85	7.34
Residual	782.66	80	9.78	
				0.05 level F = 3.97

Table 16

Significant SAI Scores Based Upon Total Score.

Scale	Attitude Assessed by SAI	ISIS Posttest $\bar{X}$	ISIS Posttest SD	IPS Posttest $\bar{X}$	IPS Posttest SD	F
I-A	The laws and/or theories of science are approximations of truth and are subject to change.	8.3	3.1	10.4	1.5	7.5
I-B	The laws and/or theories of science represent unchangeable truths discovered through science.	13.0	4.7	12.8	2.2	4.0
II-A	Observation of natural phenomena is the basis of scientific explanation. Science is limited in that it can only answer questions about natural phenomena and sometimes it is not able to do that.	16.3	5.8	21.0	2.3	18.9
III-A	To operate in a scientific manner, one must display such traits as intellectual honesty, dependence upon objective observation of natural events, and willingness to alter one's position on the basis of sufficient evidence.	15.2	5.7	18.7	2.7	5.7
III-B	To operate in a scientific manner, one needs to know what other scientists think; one needs to know all the scientific truths and to be able to take the side of the other scientists.	12.8	5.1	16.3	3.1	4.8
IV-A	Science is an idea-generating activity. It is devoted to providing explanations of natural phenomena. Its value lies in its theoretical aspects.	14.6	6.8	19.5	2.6	10.6
V-A	Progress in science requires public support in this age of science, therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.	16.3	7.0	20.6	2.7	5.0
VI-B	Being a scientist or working in a job requiring scientific knowledge and thinking would be dull and uninteresting; it is only for highly intelligent people who are willing to spend most of their time at work. I would not like to do scientific work.	9.1	3.9	13.8	1.9	7.3

SUMMARY

The SAI and the TSP inventories were administered at the beginning and the end of the fall 1978 semester to a group of ninth grade ISIS and IPS students. Analysis of the covariance was conducted on the data. No significant difference between groups was observed on the TSP. Negative gain on means scores on the SAI were observed. However, analysis of the twelve attitudes examined by the SAI showed that the IPS students showed significant gains over the ISIS students. In general the gains were shown on the positive attitude scales.

Several factors should be considered before one draws concrete conclusions. It should be remembered that both groups showed a negative gain in total scores on the SAI. In fact the ISIS group showed less reduction in mean scores on the SAI than did the IPS group. This can be interpreted that the ISIS group tended to maintain a more constant attitude toward science during the semester than did their IPS counterparts. The number of ISIS students was admittedly small in comparison to the IPS group. The posttests were administered at the end of the fall semester. Perhaps this is a normal period of anxiety for students, especially when one considers the possible psychological effect of the severe winter of 1977-78. The fact that both groups were taught by the same teacher, similar teaching methods may be used in both courses which could lead to more similarities than differences which one might expect from two courses with a dichotomy of philosophies.

It will be interesting to observe the results of similar studies conducted for longer periods of time. This researcher intends to examine data collected with the same students over a full school year.

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